ORIGINAL ARTICLE

A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project

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Objectives: To determine the relationships between physical and performance characteristics and level of skill in youth soccer players aged 12–16 years.
Methods: Anthropometry, maturity status, functional and sport-specific parameters were assessed in elite, sub-elite, and non-elite youth players in four age groups: U13 (n = 117), U14 (n = 136), U15 (n = 138) and U16 (n = 99).
Results: Multivariate analyses of covariance by age group with maturity status as the covariate showed that elite players scored better than the non-elite players on strength, flexibility, speed, aerobic endurance, anaerobic capacity and several technical skills ($p<0.05$). Stepwise discriminant analyses showed that running speed and technical skills were the most important characteristics in U13 and U14 players, while cardiorespiratory endurance was more important in U15 and U16 players. The results suggest that discriminating characteristics change with competitive age levels.
Conclusions: Characteristics that discriminate youth soccer players vary by age group. Talent identification models should thus be dynamic and provide opportunities for changing parameters in a long-term developmental context.

Structured talent identification and development programmes have been developed for several sports, in particular athletics, rowing and gymnastics, where success has been related to anthropometric, physiological and motor skill attributes.[1 2] Although corresponding programmes for soccer are less clear, many clubs selectively enrol promising players at a relatively early age and provide specialised programmes with the goal of developing and perfecting playing ability. The selection, development and professional guidance of young players is thus a priority for many top soccer clubs in order to maintain their sporting and financial status.

It is essential, however, to understand the key elements of the talent identification and development process for soccer.[3 4] Given a lack of discrete objective measures of performance, as in individual sports, identifying soccer talent is complex and requires a multivariate approach.[2 4 5] Potential predictors of soccer talent include anthropometric, physiological, neuromotor, cognitive-perceptual and psychosocial variables.[4]

Until recently, talent identification programmes in professional soccer clubs have, as a rule, not been scientifically based. The development of an objective and functional model may thus facilitate the process by identifying essential variables that distinguish elite from sub-elite soccer players, and by providing a template for the objective evaluation of such programmes. For example, among a battery of 15 anthropometric, eight physiological-motor, three psychological and two soccer-specific variables assessed in 31 soccer players (mean 16.4 years of age, range 15.8–16.7), agility, speed, ego orientation and anticipation were the strongest predictors of talent.[5] Weight, aerobic power, fatigue tolerance and dribbling also contributed significantly to the variance.

Research on talented young athletes often focuses on comparisons between youth and professional players and players classified by competitive level or expertise at a certain stage of development.[5 6] Evaluation of youth players is complicated by individual differences in the timing and tempo of changes in body size, functional capacities and motor proficiency during puberty and the growth spurt.[7 8] Age, maturity status and body size contribute significantly to variation in functional capacities (endurance, speed, power) but relatively little to variation in sport-specific skills (ball control, dribbling, passing, shooting) in soccer players aged 13–15 years.[9 10] The present study considers youth soccer players of different levels of skill and expertise. It specifically attempts to identify significant predictors of talent in Flemish youth players of different playing levels in several age groups across adolescence.

METHODS

The Ghent Youth Soccer Project (GYSP) was a 5 year mixed-longitudinal study of the growth, maturation and performance of young players. The study was approved by the Ethics Committee of Ghent University Hospital. Informed parental consent and player assent were obtained.

Participants

At the beginning of the study, 160 youth soccer players playing at different levels were enrolled (mean 12.2 ± 0.7 years of age, range 10.4–13.7). Subsequent test sessions were conducted annually over five consecutive years. Drop-outs were offset by enrolment of new players yielding a mixed-longitudinal sample of 232 players over 5 years (table 1). The most important reasons for drop-out were being injured at the date of test and being transferred to another club not participating in the study (thus influencing the player's motivation to remain in the study).

Participants were assigned to one of three subgroups according to playing level: elite – players on youth teams of first (highest) or second division clubs; sub-elite – players on

Abbreviations: BAH, bent arm hang; ESHR, endurance shuttle run; HGR, hand grip strength; MANCOVA, multivariate analysis of covariance; SAR, sit and reach; SBJ, standing long jump; SHR, shuttle run; STR, shuttle tempo run; SUP, sit-ups; VTJ, vertical jump

Table 1 Structure of data collection

	Test session				
	1	2	3	4	5
n	160	139	141	128	97
	Age categories				
	Under 13	**Under 14**	**Under 15**	**Under 16**	
n	117	136	138	99	

third and fourth division teams; and non-elite – players on regional teams. The players were grouped on the basis of chronological age into 1 year age categories (table 1): under 13 (12.0–12.9 years), under 14 (13.0–13.9 years), under 15 (14.0–14.9 years) and under 16 (15.0–15.9 years). Players $<$12 years and $\geqslant$16 years of age were excluded as were goalkeepers, limiting the analysis to defenders, midfielders and attackers.

Procedures

Chronological age, body dimensions, functional capacities, soccer-specific skills and skeletal age were noted or measured annually.

Anthropometry

Dimensions included height, body mass, 11 skinfolds (temporal, hyoideal, biceps, triceps, subscapular, mid-axillary, pectoral, abdominal, suprailiac, supra-patellar and medial calf), four circumferences (extended and flexed upper arm, mid-thigh and maximum calf) and two diameters (biepicondylar humerus and biepicondylar femur) using standardised protocols.[11] Height was measured with a fixed stadiometer ($\pm$0.1 cm) and body weight with a Seca beam balance ($\pm$0.1 kg). Skinfolds were measured with a Harpenden calliper, circumferences with a metal tape and diameters with a spreading calliper. The sum of five skinfolds (biceps, triceps, subscapular, abdominal and medial calf (SSK)) was used as an indicator of adiposity. Limb circumferences and skeletal breadths were not included in this analysis.

Functional capacities

Several tests of the EUROFIT battery were used: sit and reach (SAR) – flexibility; standing long jump (SBJ) – explosive power; hand grip strength (HGR) – static strength; bent arm hang (BAH) – upper body muscular strength and endurance; sit-ups (SUP) – abdominal muscular strength and endurance; shuttle run (SHR) – speed and agility; and endurance shuttle run (ESHR) – cardiorespiratory endurance.[12] Two additional tests were administered: vertical jump (VTJ) – explosive power; and shuttle tempo run (STR) – anaerobic capacity. The latter includes a 300 m run divided into five shuttle sprints of 10, 20, 30, 40 and 50 m in succession. Two sprint tests specific to soccer were administered: a 30 m sprint with a flying start (30 m dash, best of three trials) and a 5$\times$10 m shuttle sprint (better of two trials). The anaerobic and soccer-specific sprint test procedures are described in Philippaerts *et al*[13] and Verheijen.[14]

Soccer-specific skills

Four soccer tests were used.[15] The slalom dribble required players to navigate a ball around nine cones (2 m apart) from the start to end lines and return (better of two trials). The lob pass required the player to kick a soccer ball from a distance of 20 m into an area divided into three concentric circles (3, 6 and 9.15 m in diameter). Each kick was scored by the circle in which the ball initially landed (3, 2 and 1 points, respectively). Ten attempts (five with each foot) were allowed with a maximum of 30 points. A test of shooting accuracy required the player to kick the ball at a 16 m wide goal target from a distance of 20 m. The goal was divided into five parallel goals: centre, 2 m wide (3 points); two areas 3 m on each side of the centre (2 points); and two areas 4 m wide at each extreme (1 point). Ten shots (five with each foot) were allowed with a maximum of 30 points. For the juggling test,

Table 2 Results of the MANCOVAs with maturation as the covariate within age group: differences by age and playing level

	Age difference					Playing level (group)				
	Wilks' lambda	F	df	P	η^2	Wilks' lambda	F	df	P	η^2
Anthropometry										
Under-13	0.614	20.141	3, 96	0.000	0.386	0.946	0.899	6, 192	0.496	0.027
Under-14	0.441	44.361	3, 105	0.000	0.559	0.886	2.176	6, 210	0.047	0.059
Under-15	0.461	34.654	3, 89	0.000	0.539	0.852	2.470	6, 178	0.026	0.077
Under-16	0.514	18.877	3, 60	0.000	0.486	0.919	0.858	6, 120	0.528	0.041
Strength, power, flexibility										
Under-13	0.958	0.851	5, 98	0.517	0.042	0.869	1.429	10, 196	0.170	0.068
Under-14	0.811	5.216	5, 112	0.000	0.189	0.834	2.125	10, 224	0.024	0.087
Under-15	0.817	3.946	5, 88	0.003	0.183	0.562	5.871	10, 176	0.000	0.250
Under-16	0.886	1.474	5, 57	0.213	0.114	0.592	3.422	10, 114	0.001	0.231
Speed										
Under-13	0.998	0.050	3, 91	0.985	0.002	0.694	6.067	6, 182	0.000	0.167
Under-14	0.950	1.853	3, 106	0.142	0.050	0.755	5.319	6, 212	0.000	0.131
Under-15	0.785	8.145	3, 89	0.000	0.215	0.765	4.242	6, 178	0.001	0.125
Under-16	0.717	6.856	3, 52	0.001	0.283	0.816	1.852	6, 104	0.096	0.097
Cardiorespiratory endurance, anaerobic capacity										
Under-13	0.958	1.998	2, 91	0.142	0.042	0.911	2.174	4, 182	0.074	0.046
Under-14	0.971	1.604	2, 106	0.206	0.029	0.800	6.243	4, 212	0.000	0.105
Under-15	0.816	10.042	2, 89	0.000	0.184	0.683	9.327	4, 178	0.000	0.173
Under-16	0.854	4.698	2, 55	0.013	0.146	0.691	5.582	4, 110	0.000	0.169
Technical skills										
Under-13	0.960	1.028	4, 99	0.397	0.040	0.690	5.047	8, 198	0.000	0.169
Under-14	0.897	2.967	4, 103	0.023	0.103	0.697	5.086	8, 206	0.000	0.178
Under-15	0.961	0.933	4, 91	0.448	0.039	0.616	6.235	8, 182	0.000	0.215
Under-16	0.961	0.564	4, 56	0.690	0.039	0.778	1.869	8, 112	0.072	0.118

Table 3 Anthropometric characteristics (mean±SD) of elite, sub-elite and non-elite players by age group

	Under 13			Under 14		
	Elite (n=48)	Sub-elite (n=25)	Non-elite (n=29)	Elite (n=32)	Sub-elite (n=38)	Non-elite (n=41)
Height (cm)	151.8±6.6	151.5±5.8	153.5±7.6	157.7±8.4	161.3±7.7	160.5±8.4
Weight (kg)	40.3±6.1	40.8±4.8	42.3±8.7	44.3±6.5	48.0±7.8	46.7±8.8
SSK (mm)	34.3±11.0	39.6±12.8	38.8±15.9	36.0±9.1	38.5±15.9	44.4±19.3
	Under 15			Under 16		
	Elite (n=37)	Sub-elite (n=25)	Non-elite (n=33)	Elite (n=35)	Sub-elite (n=13)	Non-elite (n=18)
Height (cm)	167.5±8.8	167.9±7.5	168.4±9.2	171.7±7.4	174.0±8.3	175.1±7.9
Weight (kg)	53.4±9.6	52.9±8.5	54.5±10.6	57.9±8.2	60.6±9.8	60.5±9.4
SSK (mm)	$36.9\pm11.0_a$	$37.0\pm12.1_a$	$46.6\pm21.8_b$	34.6±8.1	39.0±11.7	37.8±12.0

Means in the same row for the same age category having the same subscript are not significantly different at $p<0.05$.

the number of times players touched the ball before it bounced on the ground was recorded. The juggling test (two trials) had a maximum score of 200 points (100 per attempt). The soccer tests were performed on a soccer field and players wore soccer clothing and shoes.

Skeletal age

Skeletal maturation was assessed by a paediatrician using the TW2 method.[16] The difference between chronological and skeletal ages was used as a covariate in the analysis as boys advanced in biological maturity generally perform better than boys who are on time or delayed.[7 17]

Analysis

The 17 dependent variables were grouped into five clusters for analysis: anthropometry (height, weight, SSK); strength, power and flexibility (SAR, SBJ, SUP, BAH, VTJ); speed (30 m dash, SHR, shuttle sprint); cardiorespiratory endurance and anaerobic capacity (ESHR, STR); and technical skill (lobbing, dribbling, shooting, juggling). Multivariate analyses of covariance (MANCOVA) with maturation as the covariate were used to compare the dependent variables among players within each age group by competitive level (elite, sub-elite and non-elite). Tukey post hoc tests were used after a significant main effect. Age group-specific stepwise discriminant analyses were used for performance related components with competitive level as the dependent variable. SPSS version 12.0 was used with a $p<0.05$ level of significance.

RESULTS

Results of the MANCOVAs are presented in table 2. Maturity status (that is, the difference between skeletal age and chronological age) significantly affects anthropometry in all age groups. It also significantly affects strength, power and flexibility in U14 and U15 players, and sprint speed and cardiorespiratory endurance in U15 and U16 players. In contrast, maturity status significantly influences soccer-specific skills only in U14 players.

Anthropometry

Except for SSK in U15 players, there are no significant differences in height, weight and adiposity among the groups at each age. Elite and sub-elite U15 players have significantly less adiposity than non-elite players (table 3).

Strength, power and flexibility

Strength and power differ significantly by competitive level within each age group. Among U13 and U14 players, significant differences occur primarily between the elite and non-elite groups. Further, elite and sub-elite U14, U15 and U16 players perform significantly better than non-elite players on the BAH and VTJ. Flexibility (SAR) does not differ among the groups of U13 and U14 players but is significantly greater among elite U15 and U16 players (table 4).

Speed

Sprint tests differ significantly among competitive levels within each age group (table 5). Overall, elite players exhibit significantly better sprint capacity, but group differences are most apparent in U13 and U14 players.

Cardiorespiratory endurance

The ESHR differs significantly by competitive level in each age group with elite and sub-elite players performing better

Table 4 Strength, power and flexibility (mean±SD) of elite, sub-elite and non-elite players by age group

	Under 13			Under 14		
	Elite (n=47)	Sub-elite (n=28)	Non-elite (n=31)	Elite (n=34)	Sub-elite (n=41)	Non-elite (n=45)
SAR (cm)	19.0±5.7	18.8±6.8	18.1±5.1	20.9±6.1	17.6±7.1	18.0±6.2
SBJ (cm)	$170.1\pm14.5_a$	$169.5\pm14.8_{a,b}$	$161.7\pm16.1_b$	$182.3\pm17.7_a$	$180.1\pm17.4_{a,b}$	$171.7\pm19.3_b$
SUP (n)	$26.4\pm3.9_a$	$24.6\pm3.7_{a,b}$	$23.8\pm3.5_b$	27.5±3.1	26.8±3.4	25.7±3.4
BAH (s)	$26.3\pm13.0_a$	$22.3\pm13.5_{a,b}$	$18.7\pm10.2_b$	$30.3\pm18.2_a$	$28.0\pm14.0_a$	$19.2\pm13.0_b$
VTJ (cm)	$33.7\pm4.7_a$	$32.6\pm5.2_{a,b}$	$30.8\pm4.4_b$	37.1±5.4	37.0±4.4	34.4±5.5
	Under 15			Under 16		
	Elite (n=37)	Sub-elite (n=27)	Non-elite (n=32)	Elite (n=35)	Sub-elite (n=12)	Non-elite (n=18)
SAR (cm)	$22.5\pm6.1_a$	$17.1\pm8.1_b$	$16.5\pm6.6_b$	$23.2\pm7.1_a$	$20.6\pm8.0_{a,b}$	$14.1\pm7.8_b$
SBJ (cm)	$193.4\pm13.4_a$	$191.1\pm22.1_a$	$179.8\pm20.7_b$	201.5±13.6	200.8±20.0	194.4±23.7
SUP (n)	$30.2\pm3.0_a$	$28.3\pm3.0_b$	$26.0\pm3.9_c$	$30.2\pm3.4_a$	$28.3\pm2.7_{a,b}$	$27.5\pm3.3_b$
BAH (s)	$40.4\pm19.2_a$	$31.6\pm14.5_a$	$21.0\pm13.7_b$	$40.8\pm16.4_a$	$37.1\pm17.0_{a,b}$	$24.4\pm14.9_b$
VTJ (cm)	$40.1\pm4.5_a$	$40.3\pm4.9_a$	$35.6\pm5.9_b$	44.7±5.0	45.0±5.8	41.1±6.4

Means in the same row for the same age category having the same subscript are not significantly different at $p<0.05$.

Table 5 Sprint tests (mean ± SD) of elite, sub-elite and non-elite players by age group

	Under-13			Under-14		
	Elite (n = 42)	Sub-elite (n = 24)	Non-elite (n = 31)	Elite (n = 32)	Sub-elite (n = 38)	Non-elite (n = 42)
30 m sprint (s)	$4.4 \pm 0.2_a$	$4.5 \pm 0.2_a$	$4.7 \pm 0.2_b$	$4.3 \pm 0.2_a$	$4.3 \pm 0.2_a$	$4.5 \pm 0.3_b$
SHR (s)	$20.6 \pm 1.4_a$	$21.2 \pm 1.6_{a,b}$	$21.4 \pm 1.2_b$	20.1 ± 1.5	20.2 ± 1.2	20.8 ± 1.5
Shuttle sprint (s)	$14.6 \pm 0.8_a$	$15.2 \pm 0.8_b$	$15.2 \pm 0.6_b$	$14.4 \pm 1.2_a$	$15.0 \pm 0.9_b$	$14.9 \pm 0.9_b$
	Under-15			**Under-16**		
	Elite (n = 37)	**Sub-elite (n = 25)**	**Non-elite (n = 33)**	**Elite (n = 31)**	**Sub-elite (n = 12)**	**Non-elite (n = 15)**
30 m sprint (s)	$4.1 \pm 0.2_a$	$4.2 \pm 0.2_a$	$4.4 \pm 0.3_b$	3.9 ± 0.2	4.0 ± 0.2	4.0 ± 0.2
SHR (s)	19.8 ± 1.3	20.1 ± 1.4	20.4 ± 1.2	19.4 ± 1.3	19.0 ± 1.0	19.9 ± 1.1
Shuttle sprint (s)	$13.9 \pm 0.7_a$	$14.6 \pm 1.0_b$	$14.4 \pm 1.1_{a,b}$	13.6 ± 1.0	14.2 ± 0.7	14.0 ± 0.7

Means in the same row for the same age category having the same subscript are not significantly different at $p<0.05$.

than their non-elite peers (table 6). Among U15 and U16 players, differences between the elite and sub-elite groups are also significant. The shuttle tempo run of non-elite players in the three youngest age groups is also significantly inferior compared with more skilled players. Among U16 players, the difference on the ESHR test between the elite players on the one hand and the sub-elite and non-elite players on the other is also significant.

Soccer-specific skills

Elite U13 players demonstrate significantly better dribbling, lobbing and juggling skills than non-elite players (table 7). In the U14 and U15 groups, the elite and sub-elite players perform significantly better than the non-elite players on the lobbing, dribbling and juggling tests, while in the U16 groups the elite players perform better than their peers on the lobbing (sub-elite), juggling (non-elite) and dribbling (sub-elite and non-elite) tests.

Results of the stepwise discriminant analyses for each age group are summarised in table 8. A combination of six to eight factors correctly classifies 69% to 75% of the players. Among U13 and U14 players, the variables that discriminate players by skill level include two technical, two endurance and two sprint measures. In both groups, the most discriminating factor is a soccer-specific technical skill and then two sprints (shuttle sprint and 30 m dash). In contrast, the ESHR is the most important discriminating factor among U15 and U16 players, but technical and sprint competencies are also included. Among strength-related variables, only abdominal strength-endurance (sit-ups) appears in the prediction model in U15 players. Flexibility of the lower back and upper thigh (SAR) is the second most important factor in U16 players.

DISCUSSION

Williams and Reilly[18] have suggested that process measures of performance in young soccer players may be more appropriate than performance-outcome measures as long-term predictors of potential in the sport. The present study used performance-outcome measures in a cross-sectional analysis of youth players in four age groups (U13, U14, U15 and U16). Biological maturity status (skeletal age minus chronological age) influences the size, adiposity, functional capacities and sport-specific skills of youth players. When maturity status is statistically controlled for, elite players in each age group are characterised only by less adiposity (SSK). U15 and U16 elite players showed the best results for flexibility. Elite players performed better than their non-elite peers on strength and power items, but intermediate level players (sub-elite) did not differ from the elite and non-elite players on these items. The pattern was similar for speed items, except for the U16 players. Performance on aerobic endurance and anaerobic capacity items also differed by competitive level in favour of elite players.

In contrast to anthropometry and functional capacities, only the dribbling test differed among players by competitive level at all ages. It interesting that the shooting accuracy test showed poor discriminating power and also did not differ among the four age groups. Younger players performed as well on this test as did older players. The results thus suggest that the shooting test may not be a priority item in talent identification models.

The speed items and technical skills did not differ among competitive levels in the U16 group, but elite players demonstrated better performances compared with the non-elite players. The large within-group variation was responsible for the non-significant differences.

Table 6 Cardiorespiratory endurance and anaerobic capacity (mean ± SD) of elite, sub-elite and non-elite players by age group

	Under 13			Under 14		
	Elite (n = 41)	Sub-elite (n = 24)	Non-elite (n = 31)	Elite (n = 32)	Sub-elite (n = 38)	Non-elite (n = 41)
ESHR (min)	$8.5 \pm 1.5_a$	$8.2 \pm 1.6_{a,b}$	$7.6 \pm 1.4_b$	$9.5 \pm 1.4_a$	$9.2 \pm 0.9_a$	$8.2 \pm 1.4_b$
Shuttle tempo (s)	$75.3 \pm 4.6_a$	$76.0 \pm 5.7_{a,b}$	$77.9 \pm 4.2_b$	$72.4 \pm 3.8_a$	$74.6 \pm 4.4_{a,b}$	$76.4 \pm 5.5_b$
	Under 15			**Under 16**		
	Elite (n = 37)	**Sub-elite (n = 25)**	**Non-elite (n = 32)**	**Elite (n = 33)**	**Sub-elite (n = 12)**	**Non-elite (n = 15)**
ESHR (min)	$10.8 \pm 1.2_a$	$9.4 \pm 1.4_b$	$8.7 \pm 1.7_b$	$11.2 \pm 1.6_a$	$9.8 \pm 1.0_b$	$9.3 \pm 1.6_b$
Shuttle tempo (s)	$69.6 \pm 3.5_a$	$73.3 \pm 6.2_b$	$75.2 \pm 6.2_b$	$67.5 \pm 3.8_a$	$69.7 \pm 3.1_{a,b}$	$72.2 \pm 4.8_b$

Means in the same row for the same age category having the same subscript are not significantly different at $p<0.05$.

Table 7 Soccer-specific skills (mean ± SD) of elite, sub-elite and non-elite players by age group

	Under 13			Under 14		
	Elite (n = 45)	Sub-elite (n = 25)	Non-elite (n = 36)	Elite (n = 31)	Sub-elite (n = 38)	Non-elite (n = 41)
Lobbing (points)	$20.8 \pm 4.5_a$	$21.7 \pm 4.2_a$	$16.1 \pm 5.3_b$	$22.5 \pm 3.1_a$	$22.0 \pm 3.3_a$	$19.4 \pm 5.1_b$
Dribbling (s)	$18.1 \pm 1.3_a$	$18.9 \pm 2.2_{a,b}$	$19.4 \pm 1.9_b$	$17.5 \pm 1.7_a$	$17.9 \pm 1.1_a$	$19.3 \pm 2.4_b$
Shooting (points)	23.2 ± 2.4	23.0 ± 3.0	22.0 ± 3.0	23.5 ± 2.5	23.6 ± 2.4	22.4 ± 2.2
Juggling (n)	$80.2 \pm 59.3_a$	$58.4 \pm 46.5_{a,b}$	$34.2 \pm 35.4_b$	$101.9 \pm 62.0_a$	$94.1 \pm 57.2_a$	$40.3 \pm 35.5_b$
	Under 15			**Under 16**		
	Elite (n = 38)	Sub-elite (n = 24)	Non-elite (n = 36)	Elite (n = 34)	Sub-elite (n = 14)	Non-elite (n = 15)
Lobbing (points)	$23.1 \pm 3.2_a$	$24.5 \pm 2.8_a$	$20.2 \pm 4.3_b$	23.1 ± 4.6	19.1 ± 6.0	21.0 ± 5.7
Dribbling (s)	$17.1 \pm 1.1_a$	$17.4 \pm 1.3_a$	$19.3 \pm 2.2_b$	$16.5 \pm 1.3_a$	$17.2 \pm 0.8_{a,b}$	$17.4 \pm 1.1_b$
Shooting (points)	$23.8 \pm 2.5_a$	$23.8 \pm 1.9_{a,b}$	$22.4 \pm 2.6_b$	23.8 ± 2.7	22.5 ± 4.3	21.7 ± 3.4
Juggling (n)	$117.4 \pm 52.0_a$	$105.3 \pm 59.5_a$	$59.5 \pm 57.2_b$	135.9 ± 59.4	115.2 ± 63.9	99.6 ± 70.4

Means in the same row for the same age category having the same subscript are not significantly different at $p<0.05$.

Overall, the results are generally consistent with previous research[18] in light of the fact that the sub-elite players in the earlier study (those not signed for a professional club but playing regularly for various local and school teams) corresponded to the sub-elite and non-elite players in the present design. Consistent with previous multidimensional investigations of youth soccer and field hockey, results of the present study highlight the better discriminating power of functional variables compared with anthropometric variables.[19 20] Note, however, that variation in maturity status was statistically controlled for in this study.

The current data demonstrate differences between elite players and non-elite players and to a lesser extent between sub-elite players and non-elite players. While differences between regional players on the one hand and elite and sub-elite players on the other are already apparent in early adolescence, it is possible that the distinction between elite and sub-elite players becomes more apparent in the later stages of an adolescent's soccer career. It has been suggested that it takes at least 10 years to achieve expert performance, while in soccer, on average, 18 years of age appears to be the critical time for decisions (self, club) about continuing in high level competition.[21–23] Young adult players (U21) also often experience difficulty by having less playing opportunities to progress from youth to senior level.[24] It is thus possible that in young adulthood there are greater differences between elite players (international and first national division) and sub-elite players (semi-professional or playing in lower divisions). Unfortunately, detailed information about player soccer history was not available, but elite youth players participated in 6–7 h/week of combined competitive play and soccer training per week (four or five sessions including a game), sub-elite youth players had on average 4–5 h/week (three sessions including a game) and non-elite players had on average 3–4 h/week (two sessions including a game).

Characteristics that significantly discriminated among age groups varied. Speed and soccer technique were important discriminating characteristics in U13 and U14 players, while aerobic endurance was more important in U15 and U16 players. Trunk strength/endurance (SUP), adiposity (SSK), speed (shuttle sprint and 30 m dash) and dribbling were also important discriminating factors in U15 players.

The parameters highlighted by the discriminant analyses correspond well with characteristics suggested as essential in soccer specific test batteries and with the changing

Table 8 Summary of stepwise discriminant analyses by age group: variables entered/removed*

		Wilks' lambda				Exact F			
Step	Entered	Statistic	df1	df2	df3	Statistic	df1	df2	Significance
U13 analysis									
1	30 m dash	0.781	1	2	89	12.453	2	89	0.000
2	Lobbing	0.688	2	2	89	9.052	4	176	0.000
3	Shuttle sprint	0.628	3	2	89	7.605	6	174	0.000
4	Shuttle tempo	0.558	4	2	89	7.278	8	172	0.000
5	Juggling	0.478	5	2	89	7.587	10	170	0.000
U14 analysis									
1	Juggling	0.757	1	2	115	18.439	2	115	0.000
2	30 m dash	0.666	2	2	115	12.831	4	228	0.000
3	Shuttle sprint	0.615	3	2	115	10.372	6	226	0.000
4	ESHR	0.577	4	2	115	8.870	8	224	0.000
U15 analysis									
1	Sit ups	0.679	1	2	87	20.587	2	87	0.000
2	ESHR	0.545	2	2	87	10.029	4	170	0.000
3	SSK	0.506	3	2	87	8.520	6	168	0.000
4	Shuttle sprint	0.469	4	2	87	7.630	8	166	0.000
5	Dribbling	0.427	5	2	87	7.240	10	164	0.000
6	30 m dash	0.409	6	2	87	7.696	12	164	0.000
U16 analysis									
1	ESHR	0.713	1	2	58	11.672	2	58	0.000
2	SAR	0.557	2	2	58	9.693	4	114	0.000

At each step, the variable that minimises the overall Wilks' lambda is entered. Maximum number of steps is 34; *maximum significance of F to enter is 0.05; minimum significance of F to remove is 0.10; F level, tolerance, or VIN insufficient for further computation.

What is already known on this topic

- The selection, development and professional guidance of young players is a priority for many top soccer clubs.
- Identifying talent in a team sport such as soccer is complex and a multivariate approach is appropriate.
- Evaluation of youth players is complicated by individual differences in growth spurt, functional capacities and motor proficiency during puberty.

What this study adds

- Speed and soccer technique are important discriminating characteristics in U13 and U14 players, while aerobic endurance is more important in U15 and U16 players.
- Discriminating factors among youth players may vary with the timing and tempo of the adolescent growth spurt.
- Talent identification and development is a dynamic process and differential opportunities for youths who differ in maturity and progress should be considered.

physiological demands of senior soccer.[5 25 26] Among youth players, the variation in discriminating factors may be associated with differential timing of the adolescent growth spurt and sexual maturation,[9 27] and consequently with the timing of the physical components' trainability.[28–31] Samples of 51 and 25 players were measured annually on five and four occasions, respectively, in this study. Estimated age at peak height velocity is somewhat earlier than in the general population of adolescent boys and adolescent changes in functional capacities vary relative to the timing of peak velocity of growth in height.[8] Unfortunately, sample sizes are too small for potential variation in the timing of adolescent changes to be addressed in players by competitive level. Nevertheless, longitudinal change within individual players by skill level merits consideration in future research.

The results of the present analysis demonstrate that talent identification is a dynamic process and should provide opportunities for development in the long term. This is emphasised in the analysis of Martindale *et al*[3] which highlights four important premises in the process of becoming a top level athlete: long term goals and methods, a wide range of coherent support and messages (philosophy), focus on appropriate development and not on early selection, and focus on individualised development. The results of this cross-sectional analysis of a mixed-longitudinal sample of adolescent players are suggestive but point to the need for longitudinal analysis.

As noted, the analysis is limited by its cross-sectional nature. The variables considered did not include perceptual-cognitive, tactical and psychological characteristics; although data for psychological parameters were collected at the last two time points, these data were not included because there were too few subjects for the statistical techniques used. Research on perceptual-cognitive skills of youth players is quite limited and is generally laboratory-based.[32]

In summary, the present study indicates that elite and non-elite youth soccer players differ greatly in functional capacities and sport-specific skills. Performances of sub-elite players are generally intermediate, although a clear distinction with elite players is not consistently evident. The results also highlight the relevance of specific tests at different ages during adolescence. Age-specific reference values for the total sample of youth soccer players may be useful for trainers and coaches in both the talent evaluation and development processes.[13]

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COMMENTARY

The present article offers an overview of the selection of youth soccer players. The study adopts a multidimensional approach in assessing sporting expertise in young soccer players 13–-15 years of age, controlling for variation related to maturity.

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